sparing.

Materials and Methods: We retrospectively analyzed 10 adult patients undergoing CSI at our institution. All patients were treated with TomoTherapy (Accuray, Palo Alto, USA). For comparison, all treatment plans were standardized for delivery of 36 Gy. The plans were not specifically optimized for bone marrow sparing. Additionally, for each patient we calculated a 3D conventional plan (3D-CRT) using two opposed cranial fields with two attached spinal fields. Based on the published data by J.A.Hayman et al. active bone marrow compartments were delineated. We compared the treatment plans (TomoTherapy vs. 3D-CRT) with respect to the mean values for the whole active bone marrow and calculated 'weighted bone marrow exposure' (WBME). We defined WBME as the sum of all products of mean proliferating bone marrow according to anatomical site and the mean dose to the anatomical site based on the results of J.A. Hayman et al.: WBME =∑(mean marrow according to anatomical site * mean dose to anatomical site).

Results: Mean of mean doses accross all patients for the particular bone marrow compartments are shown in the table 1. Mean values for the whole active bone marrow were higher in TomoTherapy plans for each patient with the mean difference of ca. 19% (Range 13-37%). Also when taken into account the WBME, TomoTherapy treatment plans delivered higher dose to active bone marrow in each patient, however the mean difference was lower – ca. 13% (Range 2-25%).

Table 1: Mean of mean doses according to the particular bone marrow compartment

	Mean values and their range accross all patients in Gy				Difference	
	Tomotherapy		Conventional		Absolute	Relative
Pelvis	7,7	(4,5-14,0)	1,2	(0,5-2,4)	6,6	551%
Thoracic spine	33,5	(30,3-34,9)	33,7	(32,1-39,9)	-0,2	-1%
Lumbar spine	32,2	(26,9-35,7)	33,2	(28,8-38,0)	-0,9	-3%
Sacrum	29,3	(22,9-33,2)	25,8	(14,0-34,8)	3,6	14%
Ribs&clavicles	8,6	(5,8-11,5)	4,0	(1,5-6,2)	4,6	116%
Prox. femuri	0,7	(0,0-1,1)	0,3	(0,2-0,6)	0,4	166%
Cervical spine	35,8	(34,5-36,5)	34,6	(32,7-37,5)	1,3	4%
Scapulae	4,0	(1,8-6,6)	0,7	(0,3-2,4)	3,2	438%
Sternum	11,7	(7,2-16,1)	19,1	(17,3-21,4)	-7,4	-39%
Skull	32,7	(30,8-34,4)	31,0	(29,8-33,7)	1,7	5%
Prox. humeri	2,5	(0,2-4,8)	0,3	(0,1-1,1)	2,2	772%
Whole bone marrow	19,5	(16,3-23,4)	16,3	(12,8-18,1)	3,1	19%

Conclusions: If not optimized to spare active bone marrow CSI, 3D-CRT is superior to TomoTherapy with respect to active bone marrow sparing. Except for the sternum, 3D-CRT results in almost equivalent or better dose sparing of all bone marrow compartments. To evaluate the bone marrow sparing the use of WBME seems prudent as the quantitative active bone marrow distribution doesn't follow the absolute bone marrow distribution. Whether active bone marrow sparing optimized TomoTherapy plans yield superior results is a matter of ongoing research.

PO-0807

Radiosurgery and brain metastases: high-resolution MRI can significantly change intracranial disease staging

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Purpose/Objective: Proper staging of intracranial disease with an accurate assessment of the exact number of brain lesions is of utmost importance in the decision-making process for the appropriate treatment of patients with brain metastases. The diagnostic efficacy in the detection of additional brain metastases of a three-dimensional, T1-Weighted Gradient-Echo Imaging with a double contrast was evaluated

Materials and Methods: Before undergoing radiosurgical treatment, patients underwent a brain magnetic resonance imaging (MRI) scan to be used during the treatment planning in order to contour the targets and to locate the brain lesions as they relate to the stereotactic frame.

All the patients underwent a post-contrast study with T1-weighted, 3D Magnetization-Prepared Rapid Acquisition Gradient Echo (MP RAGE) sequence. We used a double dose of gadobenate dimeglumine and slice thickness of 1 mm.

Results: Starting from October 2012 to August 2014, we treated with Gamma Knife radiosurgery (GKRS) 113 patients with brain metastases. On the diagnostic MRI, all the patients had a number of lesions ≤4. Median time interval between diagnostic MRI scan and the day of GKRS was 13 days (range 5-22)

A total of 87 additional lesions were detected on MR imaging performed in the same day of the GKRS in forty patients out of 113 (35.4%). A median number of 2 additional lesions were detected (range 1-11). Among these 40 patients only 18 patients had a number of lesions ≤4 on the day of treatment. Patients with a total number of lesions ≤10 were treated with GKRS. Two patients with a total number of lesions > 10 were treated with whole brain radiotherapy (WBRT).

Conclusions: A double-contrast study with T1-weighted, volumetric MPRAGE sequence, using acquisition of contiguous 1-mm slices may offer a definitely better staging for patients with brain metastases. In our opinion, a diagnostic high resolution MRI should be recommended in all the patients with newly diagnosed brain metastases because the detection of the real number of lesions is crucial for an adequate treatment and it also may lead to choose different therapeutic strategies other than radiosurgery.

PO-0808

Hadrontherapy in skullbase chordoma: CNAO experience

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Purpose/Objective: CNAO (Centro Nazionale di Adroterapia Oncologica) started clinical activity with proton beam in

September 2011, and with Carbon ion beam in 2012. Skullbase chordomas are known as radioresistant tumors. Escalating the dose to target volumes and sparing normal organs is recommended to ensure adequate local control with low toxicity.

Materials and Methods: Since September 2011, 67 patients (F/M : 25/42) with histologically verified diagnosis of skullbase chordomas have been treated at CNAO. All patients underwent first one or more surgical procedures, and then were irradiated on macroscopic residual disease or on the site of local relapse (2 patients had local relapse after complete resection). Thirty nine patients have been treated with proton beam, up to a total dose of 74 GyE in 37 fractions, 2 GyE/fraction over 5 days per week, twenty eight patients with carbon ion up to70.4 GyE in 16 fractions, 4.4 GyE/fraction over 4 days per week. Each patient underwent clinical examination during, at the end and every three months after the treatment. Acute and late toxicity data were recorded according to CTCAE v.4.0 score. Clinical outcome was evaluated with trimestral MRI according to RECIST criteria.

Results: Treatment has been in general well tolerated, with acute toxicity G0/G1, G2 and G3 reported respectively in 74%, 24% and 2% patients; one patient died for causes not treatment related.

With 15 months median follow up time (range 2 – 27), local control was achieved in 51 patients (over the 54 who reached the first follow up visit), partial response in 2, and complete response in 1. No progression disease has been reported. In the 34 patients who reached 12 months follow up, 26 patients were scored with late toxicity G0/G1 (alopecia, fatigue, dysphagia, headache, hearing loss), and 8 patients with G2 (pituitary deficit, neuropathy, asymptomatic brain dysfuncion).

Conclusions: Our data show safety and effectiveness of handrontherapy for skullbase chordomas although the limited number of patients and the short follow up time. Longer follow up are needed.

PO-0809

MRS Choline/NAA enhancement is a predictor of post-RT disease-free survival time in glioblastoma multiforme

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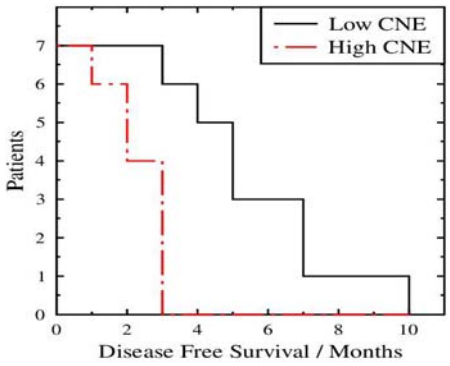
Purpose/Objective: In brain 1H Magnetic Resonance Spectroscopic Imaging (MRSI) elevated choline and reduced NAcetylAspartate (NAA) levels are both indicators of cancerous tissue and the Choline/NAA Ratio (CNR) is a widely studied parameter for evaluating tumor metabolic function. In this study we compare CNRs in healthy tissue and tumor across a cohort of GlioBlastoma Multiforme (GBM) patients and investigate the link between spectroscopic abnormality and disease-free survival after treatment.

Materials and Methods: 14 patients diagnosed with GBM underwent an MRSI exam as part of the (post-operative) radiotherapy treatment planning imaging process. The scan was a PRESS localized CSI with 10x10x8 voxels of approximately 0.5cc, TE/TR=135ms/1.5s. Data was processed, quantified, registered to the coacquired T1 contrast enhanced scan and resampled to the T1 resolution using a custom tool developed in-house. After treatment, every patient received follow up MRIs every 1-2 months until relapse.

Amongst GBM patients a GTV to CTV margin of 20mm is typically used to account for microscopic spread. Voxels greater than 20mm outside the CTV contour were classified as 'normal' and for each patient a Gaussian distribution was fitted to the CNRs of these voxels to obtain a mean normal CNR. As the CNRs in the contrast enhanced region do not typically form a Gaussian distribution, the median value was utilised. The Choline/NAA Enhancement (CNE) was defined as the ratio between median tumour CNR and mean normal CNR.

Results: The normal tissue CNR across the group was 0.84 +/- 0.10, showing a wide range of healthy tissue values across patients. Four patients exhibited no voxels with spectroscopic abnormalities. The mean CNE was 1.73 +/- 0.65.

Patients were divided into two groups (equal in number) based on the mean CNE and disease-free survival curves for both were constructed using the Kaplan-Meier estimator, shown in the figure, then compared using the log rank test, which showed a significant difference (p=0.00645) between the two groups.



Conclusions: Our study found the baseline levels of metabolites to vary substantially between patients (attributable at least in part to tumor location), so that an absolute threshold for abnormal CNR cannot be determined for all patients. Instead we proposed a measure of relative abnormality, CNE, which can be compared across patients. There is a statistically significant relationship between our CNE and the disease-free survival of our patient cohort. Thus this study demonstrates that spectroscopic analysis of the CNE could help guide treatment planning by indicating patients who might benefit from more radical radiotherapy options such as dose boosting. The metric could also be used to tailor patient follow-up in order to more closely monitor patients with high risk of early relapse.

PO-0810

Impact of low dose radiation therapy with Bevacizumab in recurrent glioblastoma: final report

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